A STUDY OF CHANGES IN PHYSIOLOGICAL FUNCTIONING DURING THREE FIVE AND EIGHT OVER PACE BOWLING IN CRICKET

A Synopsis

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CHAPTER I

INTRODUCTION

It is well known that impairment of performance resulting from muscle fatigue differs according to the types of contraction involved, the muscular groups tested and the exercise duration/intensity. Previously published research on physiological responses to fast-bowling is minimal; however, Burnett, Elliott, and Marshall (1995), Stretch and Lambert (1999) and Devlin et al. (2001) have reported heart rate responses to simulated 12, 6 and 2×6-over spells, respectively. Collectively, these studies indicate heart rate responses in the range of 75–85% of maximal heart rate (155–175 beats/min71). Burnett et al. (1995) reported blood lactate values [La7] throughout the 12 over spell of 4–5 mmol/L 71, while Gore, Bourden, Woolford, and Pederson (1993) reported higher sweat rates for fast bowlers during hot days (1.5 L/ h71), and significantly lower sweat rates on warm or cool days (51.0 L / h71). However, few of these studies report the association between these physiological measures and performance. Devlin et al. (2001) reported no change in bowling speed during 6-over spells when either in a dehydrated or hypo hydrated state, however, a decrement in bowling accuracy was noted when in a hypo hydrated state.

Since to date, there is a lack of research outlining the acute physiological responses to fast-bowling, the extent of change in bowling speed or accuracy or the relationship between physiological responses and bowling performance (Bartlett, 2003), the researchers felt worthwhile to further examine the alternations of physiological function during 8-over spell on pace bowlers in Indian condition.

Statement of the Problem

The purpose of this study is to examine the time course of impairment in physiological responses namely Heart rate, Blood pressure, core body temperature and blood lactate during a long-duration of bowling spell on pace bowler in Indian condition.

The Objectives of the Study

The following objectives are set for the present study

(1) To assess the influence of an 8-over spell on cricket fast bowling performance (speed and accuracy);

(2) To determine the interrelationships between selected physiological variables and performance during an 8-over spell.

(3) To determine the significant changes in selected physiological variables takes place during a long-duration of bowling spell.

Delimitations

The study will be delimited to the following factors.

1) Twenty subjects will be selected from West Bengal.

2) The age of the subjects will be ranged from 18 to 25 years.

3) Data will be collected prior to the 1st over and immediately after the completion of 3rd, 5th and 8th overs.

4) The selected physiological variables will be heart rate, blood pressure, core body temperature and blood lactate.

5) The heart rate, blood pressure, core body temperature will be recorded by using Pedometer, sphygmomanometer and thermometer respectively and the blood lactate will be measured by Blood Lactate Analyzer.

6) The selected bowling Performance variables will be ball speed, accuracy and full and final 5-m run-up speed on each ball.

7) The ball speed, accuracy and full and final 5-m run-up speed on each ball will be measured by Radar Gun, Naraashans Cricket Bowling Accuracy Test and Stop watch respectively.

Limitations

The following limitations will be considered

1) The previous experience of the subjects in the field of sports and games, which might influence the training and data, will be not considered.

2) Psychological factors, food habits, rest period, life style etc., will not be controlled.

3) The weather conditions such as atmospheric temperature, humidity and meteorological factors during testing and training periods will also not be considered.

4) Though the subjects are motivated verbally no attempt will be made to differentiate the motivation levels during the period of training and testing.

Hypothesis

Based on the studies of Rob Duffield, 2009 and Marc R. Portus, 2000, it is hypothesized that

H_1 All the physiological variables will be impaired after 5^{th} over of bowling.

H_2 Onset of fatigue will have a significant effect on bowling speed and accuracy.

H_3 There will be a significant relationship between selected physiological variables and performance during an 8-over spell.

Definition and Explanation of the terms:

a) **Blood Lactate:** Lactic acid that appears in the blood as a result of anaerobic metabolism when oxygen delivery to the tissues is insufficient to support normal metabolic demands. (Mosby's Medical Dictionary, 8th edition. © 2009, Elsevier)

b) **Heart Rate**: Heart rate, or heart pulse, is the speed of the heartbeat measured by the number of contractions of the heart per unit of time — typically beats per minute (bpm). (Wikipedia)

c) **Blood Pressure:** Blood pressure (BP)is the pressure exerted by circulating blood upon the walls of blood vessels.(Wikipedia)

d) **Core Body Temperature:** Core body temperature refers to the temperature of the internal environment of the body. This includes organs such as the heart and liver, as well as the blood. (study.com/academy/lesson/core-body-temperature-definition-measurement.html)

e) Pace Bowler: Pace bowlers, who use the velocity of the ball to effect dismissals. (www.learn-cricket.com/eng/bowlers5.php)

f) Bowling Spell: A spell is a chain of overs a bowler bowls at a stretch. It may vary from a 2 over spell to a 10 over spell in an ODI. In tests a bowler can bowl any number of overs at a stretch. (www.quora.com/What-is-a-bowling-spell-in-cricket).

g) Cricket: Cricket is a bat-and-ball game played between two teams of 11 players each on a field at the centre of which is a rectangular 22-yard-long pitch. (Wikipedia).

Significance of the Study

1. The results of the study will enlighten on the physiological responses of the pace bowlers and their fitness
2. It would enhance the awareness of fitness and bowling directives among the players and coaches.
3. The study may reveal new facts regarding how much a pace bowler can bowl repeatedly during practice session or match.
4. The result of the study may provide latent justifications for severe impairment in physiological responses.
5. The study will have revealed facts would contribute to the physical educationists, sports scientists and cricket scientists to enhance their knowledge about the pace bowlers especially who belongs to West Bengal.

CHAPTER II

REVIEWS OF RELATED LITERATURE

A study of the relevant literature as an essential step with regard to the problem under study that brings about a deep insight and a clear perspective of the overall field is described in this chapter.

Rob Duffield et.al, 2009 studied the relationship between physiological and performance responses during repeated 6-over fast-bowling spells. Six, first-class, medium-fast bowlers performed 2×6-over spells separated by 45 min of light activity. The 6-over spells were based on the Cricket Australia fast bowling skills test that is a set order of deliveries at a grid-based target. Ball speed, accuracy and full and final 5-m run-up speed were measured on each ball. Nude mass, heart rate, core temperature, capillary blood lactate, pH and glucose, perceptual measures of RPE and muscle soreness (MS) and repeated vertical jump efforts were measured prior to, during and following each spell. Results indicated no decrement (P¼0.41) and small effect sizes (d50.2) in bowling speed (125.7+5.1 and 125.4+4.5 km / h71) or accuracy (40.4+16.1 and 41.6+18.0 AU) between spells 1 and 2. No differences (P¼0.670.8) were present between spells for heart rate, core temperature, lactate, pH, glucose, RPE, MS or vertical jump. Only final 5-m run-up speed showed a large correlation with ball speed (r¼0.70), while accuracy and speed were not correlated (r¼0.05). In conclusion, repeated 6-over spells in well-trained bowlers results in minimal performance decrement in mild conditions (22.8C). As faster bowlers had faster final 5-m run-up speeds, the maintenance of high final 5-m run-up speeds might be important to maintaining bowling speed. Future research should also include a third bowling spell and warmer environmental conditions.

Marc R. Portus et.al, 2000 conducted a study to determine the influence of an 8-over spell on cricket fast bowling technique and performance (speed and accuracy), and to establish the relationship of selected physical capacities with technique and performance during an 8-over spell. Fourteen first-grade fast bowlers with a mean age of 23 years participated in the study. Physical capacities assessed were abdominal strength, trunk stability, selected girth and skinfold measure. During the delivery stride, bowlers were filmed from an overhead and lateral perspective (50 Hz) to obtain two-dimensional data for transverse plane shoulder alignment and sagittal plane knee joint angle respectively. Ball speed was measured by a radar gun and accuracy by the impact point of each delivery on a zoned scoring target at the batter's stumps. Shoulder counter-rotation did not change significantly between overs 2 and 8 for all bowlers but was significantly related to a more front-on shoulder orientation at back foot impact. When the front-on fast bowlers (n = 5) were isolated for analysis, shoulder counter-rotation increased significantly between overs 2 and 8. Ball speed remained constant while accuracy showed some non-significant variation during the spell. Shoulder counter-rotation was significantly related to accuracy scores during the second half of the 8-over spell. Chest girth and composition and body composition were significantly related to ball release speed at various times during the spell.

Place, N.et.al, 2004 investigated the time Course of Neuromuscular Alterations during a Prolonged Running Exercise. Nine well-trained triathletes and endurance runners sustained 55% of their maximal aerobic velocity (MAV) on a motorized treadmill for a period of 5 h. Maximal voluntary contraction (MVC), maximal voluntary activation level (%VA), and electrically evoked contractions (single and tetanic stimulations) of KE muscles were evaluated before, after each hour of exercise during short (10 min) interruptions, and at the end of the 5-h period. Oxygen uptake was also measured at regular intervals during the exercise. Reductions of MVC and %VA were significant after the 4th hour of exercise and reached -28% ($P < 0.001$) and -16% ($P < 0.01$) respectively at the end of the exercise. The reduction in MVC was highly correlated with the decline of %VA ($r = 0.98$, $P < 0.001$). M-wave was also altered after the fourth hour of exercise ($P < 0.05$) in both vastus lateralis and rectus femoris muscles. Peak twitch was potentiated at the end of the exercise (+ 18%, $P < 0.01$); 20- and 80-Hz maximal tetanic forces were not altered by the exercise. Oxygen uptake increased linearly during the running period (+18% at 5 h, $P < 0.001$). These findings suggest that KE maximal voluntary force generating capability is depressed in the final stages of a 5-h running exercise. Central activation failure and alterations in muscle action potential transmission were important mechanisms contributing to the impairment of the neuromuscular function during prolonged running.

J. Bangsbo.et.al 2005 studied the physical and metabolic demands of training and match-play in the elite football player. In soccer, the players perform intermittent work. Despite the players performing low-intensity activities for more than 70% of the game, heart rate and body temperature measurements suggest that the average oxygen uptake for elite soccer players is around 70% of maximum (V O2max). This may be partly explained by the 150 – 250 brief intense actions a top-class player performs during a game, which also indicates that the rates of creatine phosphate (CP) utilization and glycolysis are frequently high during a game. Muscle glycogen is probably the most important substrate for energy production, and fatigue towards the end of a game may be related to depletion of glycogen in some muscle fibres. Blood free-fatty acids (FFAs) increase progressively during a game, partly compensating for the progressive lowering of muscle glycogen. Fatigue also occurs temporarily during matches, but it is still unclear what causes the reduced ability to perform maximally. There are major individual differences in the physical demands of players during a game related to physical capacity and tactical role in the team. These differences should be taken into account when planning the training and nutritional strategies of top-class players, who require a significant energy intake during a week.

A.S.R. Silva.et.al 2008 investigated the Psychological, biochemical and physiological responses of Brazilian soccer players during a training program**.** The aim of this study is to investigate the behavior of the physiological, biochemical and psychological parameters in Brazilian soccer players during a training program. Fifteen athletes were evaluated at the beginning (T1), in the middle (T2) and at the end (T3) of the training program. On the first day, at 7:30 am, before the blood collecting at rest for the determination of serum creatine kinase (CK), serum creatinine and serum urea, the athletes had their psychological parameters assessed by the profile of mood state questionnaire (POMS). After 90 min, they performed a 250-m sprint. On the second day at 8:30 am, the athletes had their alactic anaerobic performance measured and, after 40 min, they completed the aerobic test. Friedman test was used to verify the behavior of overtraining markers. There was a decrease in vigor score in T3 ($p = 0.01$) compared with T1 and T2. In T3 ($p = 0.01$), the athletes also showed an increase in serum creatinine levels compared to T1. Furthermore, in the same period, we verified a diminishing in the team performance. The training program developed between T2 and T3 led to the fall of the vigor score, the increase in serum creatinine concentrations and the diminishing in team performance.

CHAPTER III

METHODOLOGY

In this chapter Selection of the subjects, Selection of parameters, Collection of data, Design of Study, and Statistical techniques to be employed for data analysis are described in brief.

Selection of Subjects

Twenty male pace bowlers 18 to 25 years from West Bengal will be recruited for this study. At the time of testing all the subjects will bowl without being restricted by injury and all are "match fit". A written and verbal informed consent prior to engaging in any testing will be taken from all players gave.

Criterion Measures

The test items selected for this study will be standardized and appropriate for the physiological responses on selected parameters. The criterion measures are presented in the **table-1**.

TABLE-1

TESTS SELECTION

Sl.No	Criterion Variables	Test Items	Criterion Measures
1	Heart Rate	Pedometer	Beats/Min
2	Blood Pressure	Sphygmomanometer	mmHg
3	Core Body Temperature	Thermometer	Centigrade
4	Fatigue	Blood lactate analyzer	mmol/L
5	Ball Speed	Radar Gun	Kpm/H
6	Ball Accuracy	Naraashans Cricket Bowling Accuracy Test	Points
7	Body Composition	Height	Meter
		Weight	Kilograms

Research Design

The experimental design will be used in this study is repeated measures design.

Pre-Testing

Prior to the beginning of the experimental protocol subjects standing heights and weights will be measured by using stadiometer, weighing machine and history of injury information will be taken from the bowlers.

The selected physiological variables namely heart rate, blood pressure, core body temperature and blood lactate will be measured prior to the first over.

Experimental Protocol

For the purpose of the experimental protocol after a standardized warm-up, each bowler will bowl 8 overs (six-ball) to a batsman in a cricket net where a simulated real match conditions will be conducted, (i.e. where two bowlers consecutively bowl their six-ball overs).

At the completion of each over, one subject would alternately rest and complete fielding drills while the other subject would bowl their over. This alternative process continued until 8 overs will be completed by each subject. To replicate the fluid replenishment the bowlers will be allowed to take fluid after completion of their each over. The overs will be bowled at an average rate of 15 overs per hour, which represent the typical inter University tournament matches conditions.

Instrument and tools to be used

The instrument and tools to be used for this study are presented in the **table-2.**

TABLE-2

INSTRUMENT AND TOOLS USED

Sl.No	Criterion Variables	Instrument
1	Heart Rate	Pedometer
2	Blood Pressure	Sphygmomanometer
3	Core Body Temperature	Thermometer
4	Fatigue	Blood lactate analyzer
5	Ball Speed	Radar Gun
6	Ball Accuracy	Naraashans Cricket Bowling Accuracy Test
7	Body Composition Height Weight	 Stadiometer Weighing Machine

Administration of Tests

1. **Height**

Purpose

To measure the height of the subjects.

Equipments use

Stadiometer, score sheet and piece of chalk are used.

Procedure

The subject stood on the stadiometer with barefoot. At the time of measuring the heels are on the platform without elevating it. The scale is brought down firmly in conduct with vertex. A mark is made with chalk piece on the side of the scale on the stadiometer. After that the subject stepped away from the stadiometer stand board and measurement is taken.

Scoring

The vertical distance from the stadiometer stand board to chalk piece mark is measured. The measurement is taken to the nearest one centimeter. **(Johnson and Nelson, 1988)**

2. **Body Mass/ Weight**

Purpose

The purpose of the test is to measure the weight of the subject.

Equipments use

Weighing machine, and score sheet.

Procedure:

The subject stood on the weighing machine with barefoot and with minimum clothing. The heels are on the weighing machine without elevating it and the body is kept at erect position. After the scale vibration is stopped the reading is recorded in kilograms.

Scoring:

The weight is recorded to the nearest to a kilogram. **(Johnson and Nelson, 1988)**

3. **Heart Rate**

Purpose

The purpose of the test is to measure the heart rate of the subject.

Equipments use

Pedometer.

Procedure

Before the 1st and after 3rd 5th and 8th over heart rate will be taken by using the pedometer. The subject wears the pedometer on the non-bowling hand thorough the test. The pedometer will start just before the bowling in every over and remain switched on throughout the over. After that reading will be recorded in Beats/Min. This process will be followed up to the 8 over of his bowling spell.

Scoring:

The heart rate will be recorded in Beats/Min.

4. **Blood Pressure**

Purpose

The purpose of the test is to measure the Blood Pressure of the subject.

Equipments use

Sphygmomanometer.

Procedure

Before the 1st and after 3rd 5th and 8th over blood pressure will be taken by using the Sphygmomanometer. To begin blood pressure measurement, use a properly sized blood pressure cuff. The length of the cuff's bladder should be at least equal to 80% of the circumference of the upper arm. Wrap the cuff around the upper arm with the cuff's lower edge one inch above the antecubital fossa. Lightly press the stethoscope's bell over the brachial artery just below the cuff's edge. Some health care workers have difficulty using the bell in the antecubital fossa, so we suggest using the bell or the diaphragm to measure the blood pressure. Rapidly inflate the cuff to 180mmHg. Release air from the cuff at a moderate rate (3mm/sec). Listen with the stethoscope and simultaneously observe the dial or mercury gauge. The first knocking sound (Korotkoff) is the subject's systolic pressure. When the knocking sound disappears, that is the diastolic pressure (such as 120/80)

Scoring:

The Blood Pressure is recorded in mmHg.

5. Core Body Temperature

Purpose

The purpose of the test is to measure the Core Body Temperature of the subject.

Equipments use

Thermometer.

Procedure

Before the 1st and after 3rd 5th and 8th over Core Body Temperature will be taken by using the Thermometer. When taking an oral temperature, shake down the glass mercury thermometer to 96°F (35°C) or below. This procedure is not needed for digital thermometers. Have the subject place the thermometer under one side of the back of the tongue. Instruct the subject to close both lips around the thermometer and breath through his nose. Wait 3-5 minutes for a mercury thermometer or until the digital beep sounds if

using a digital device. If using a mercury thermometer, reinsert the thermometer after the initial reading for 1 minute and read again. If the temperature is still rising, repeat this procedure until the reading remains stable.

Scoring

The Core Body Temperature is recorded in Centigrade.

6. Fatigue

Purpose

The purpose of the test is to measure the fatigue of the subject.

Equipments use

Blood lactate analyzer

Procedure

Before the 1^{st} and after 3^{rd} 5^{th} and 8^{th} over fatigue will be taken by using the Blood lactate analyzer. Accutrend Plus measures blood lactate (muscle performance indicator) very quickly on a tiny drop of blood. This results in a virtually painless, yet fast and accurate test for lactate. Lactate is the premier indicator of aerobic conditioning for athletes and a key predictor of competitive performance. Lactate tests on other meters are painful and therefore difficult to incorporate into routine training. They need from 5 to 25 microliters of blood, requiring a deep, wide-gauge lance to pierce the skin deeply enough to obtain a large sample. Accutrend Plus requires only 0.15 microliters of blood. This allows use of the thinnest, most shallow, least painful lancing devices available, increasing the athlete's tolerance for testing. The older technology used by other lactate meters requires more time for test results. Accutrend Plus takes only 60 seconds. This speed means that lactate testing will be less intrusive on the athlete's training. Accutrend Plus from Roche is a flexible, portable device for patient-side measurement of lactate. The same high standards for accuracy and reliability that are required for hospital use have been incorporated into the Accutrend plus meter.

Scoring

The fatigue is recorded in mmol/L.

7. Ball Speed

Purpose

The purpose of the test is to measure the bowling speed of the subject.

Equipments use

Rader gun.

Procedure

The Rader gun will start just before every ball and will be stopped when the ball pitched on the ground. After that reading will be recorded in km/h this process will be followed up to the 8 over of his bowling spell.

Scoring

The bowling speed will be recorded in km/h.

8. Ball Accuracy

Objective of the Test

The test will be ideated with the single objective i.e. to construct the test which assesses the bowling accuracy of male cricketers.

Utility of the Test:

Modern day's cricket has been transformed into more competitive & become more aggressive where every player has to put extra efforts in order to perform at the optimum level. In such a scenario, players have no objective method to analyze their bowling skills, and moreover traditional methods have been adopted in the selection process by letting the bowlers bowl mechanically where even neither they nor selectors concentrate on no-balls. Due to the preceding reasons, the authors set out to construct a bowling accuracy test for the cricketers. The most important aspect of the test is that it will play an instrumental role to boost the confidence level of the bowlers & the selection process will become more objectified.

Nomenclature of the Test:

Every motor-skill test has been christened by the choice of the testers, this test is henceforth christened as the NARAASHANS CRICKET BOWLING ACCURACY TEST, and where-in Naraashans is the Vedic word means ‘a praised man’ or ‘a man who has been eulogized among mankind’

Equipments:

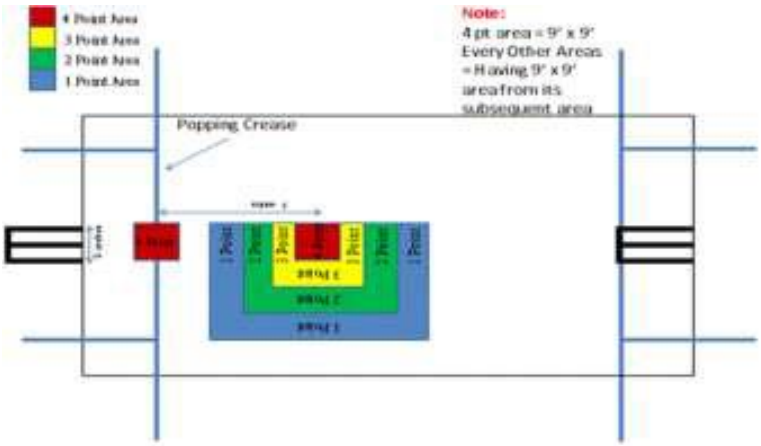
Following equipments are needed for the proper execution of the test:

a. Measuring tape (30 mt.) 1
b. Coloured chalks As per the requirement
c. 4-piece standard cricket balls
d. Rope (10 mt.) & Nails 1 & 2 pcs
e. Score sheet 1 per Bowler
f. Pen/pencil as per the requirement

Marking for the Test:

A square of 9 inches with its center is drawn at a distance of 3 metre from the popping crease. The back line of the square must be perpendicular to the leg stump that represent the four (4) point area and is as per the standard measurement of the distance of cricket stumps i.e. 9 inches. A square of 9 inches is also drawn on the batting crease (i.e. block-hole of the batsman) just in front of the stumps that also represent the four (4) point area. Three (3) point area is drawn by extending 9 inches from above, below and front side of the four (4) point area. Two (2) point area is made by extending 9 inches from above, below and front side of the three (3) point area. Similarly, one (1) point area is drawn by extending 9 inches from above, below and front side of the two (2) point area. All lines are 3cm thick and included in their respective point areas. The foregoing marking areas shall be the target zones for the bowlers.

Diagram of the test



Procedure of Collection of Data

Prior to commencement of 1st over and immediately after the completion of each 3rd, 5th, and 8th overs the heart rate, blood pressure, core body temperature and Blood lactate will be recorded by using Pedometer, Sphygmomanometer, thermometer and blood lactate analyzer respectively.

Players will be instructed to replicate the intensity and accuracy of match bowling during the testing session. During the 8-over spells (48 balls), each ball will be monitored for speed and accuracy. Ball speed will be recorded with the use of a radar gun, positioned 10-m behind the bowler's arm and aimed to measure speed at ball release. Ball accuracy will be measured with a scoring system developed for the Naraashans Cricket Bowling Accuracy Test. Run-up speed will be measured with a stopwatch to determine overall and final 5-m run-up speed.

Before and after the testing session, nude body mass will be measured to determine change due to sweat loss including the measurement of all fluids consumed during the testing session by weighing individual drink bottles (HW100K, A and D, Japan).

Perceptual measures

The physiological markers of the intensity of fast bowling will be measured by Self-reported Rate of Perceived Exertion (RPE) during pre-spell, and following the 3rd, 5th over and after the 8th over spell. RPE will be determined from the Borg CR- 10 scale that is a 10-point scale where 0 represents ''Nothing at all'' through to 10 ''Maximum''.

Analytical Procedure to be used

The basic statistical parameters will be calculated for all the data: the mean and standard deviation.

One-way, repeated measures ANOVA will be performed to determine differences between the respective 8-over spell, with significance level set at $P < 0.05$.

Pearson's correlation co-efficient analysis will be performed to determine the association between physiological variables and bowling performance.

The rate of impairment will be calculated by percentage method.

KEY WORDS:

PHYSIOLOGICAL, BALL SPEED, BALL ACCURACY, BOWLING SPELL, PACE BOWLING, CRICKET

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